

The Delaware Irrigation Management System (DIMS) User's Guide

"A Web-based Irrigation Scheduling Tool for Delaware"

Version 1.1

May 24, 2012

DIMS is an online system designed to provide members of the Delaware agricultural community access to irrigation scheduling software that's streamlined and tailored to Delaware. While irrigation scheduling software has been used in practice by some members of the community in the past, many of the software applications used still require extensive knowledge about a farm field's soil properties and crop physiology. Also, many of meteorological data resources required in these software applications have to be entered manually because the inherent data resources within them are tailored to other regions. DIMS was created to reduce the amount of effort required of the user both prior to and during the growing season. DIMS provides a straightforward, online interface that allows the user to quickly determine if a field has adequate soil moisture to satisfy the crop's water requirements.

I. Overview

DIMS uses an irrigation scheduling method based on the basic water balance. Output from evapotranspiration is calculated and tracked and compared to inputs from rainfall and irrigation to determine the amount of water available in the soil to a particular crop. Through this method, which is generally referred to as the "checkbook" method, a user hopes to optimize the amount of soil water required by the crop, thus reducing crop stress, improving crop yield, and reducing nutrient loss. DIMS utilizes the method described in FAO Irrigation and Drainage Paper No. 56, *Crop Evapotranspiration Guidelines for Computing Crop Water Requirements* (FAO56; Allen et al., 1998).

Weather and Climate Data

This method depends on the calculation of ET_o , which is the combination of evaporation of water from the reference surface and transpiration from reference surface vegetation. DIMS uses ET_o from DEOS, which is calculated using the FAO Penman-Monteith method with a reference surface of a well-kept grassy surface with adequate water available at all times (i.e., no water stress). This ET_o is not necessarily representative of actual evapotranspiration from a crop surface. To calculate crop evapotranspiration (ET_c), crop-specific coefficients based on physical and statistical relationships described in FAO56 are used to convert ET_o to something more representative. This term represents the primary output from the field. DEOS rainfall data and irrigation data entered by the user are used by the model as the primary inputs. The result of the inputs minus the outputs is the soil water storage available to the plant. DEOS rainfall and ET_o data are automatically updated in DIMS for every field created by the user to make data entry more convenient.

Soil Property Data

Soil hydrologic properties are required by the irrigation scheduler model in order to determine soil water availability in the root zone of the crop. DIMS uses dominant soil texture class data of the top 24 inches (2 feet) from the United States Department of Agriculture's Natural Resource Conservation Service's (NRCS) Soil Survey Geographic Database (SSURGO). DIMS allows a user to specify a custom soil texture by defining its available water holding capacity (field capacity) and permanent wilting point. This process is described later in Section IV.

II. Getting Started

DIMS is a web based system, thus it requires a user account to gain access. Currently, the only way to obtain a user account is to visit the DIMS login page (<http://www.deos.udel.edu/dims>) and click on the "Request an Account" link. This step will provide an account request form that can be submitted to a DEOS system administrator. Following this step, a username and password will then be e-mailed to the user, whereupon they may begin using DIMS.

III. Adding Fields to DIMS

DIMS is designed to minimize the amount of information a user needs to know about their fields in order to use the system. Thus, DIMS only requires four basic items of information in order to add a field to the system: 1) a name for the field, 2) the type of crop being grown in the field, 3) the date the crop was planted, and 4) the location of the field. While there are some advanced field settings that can be modified, those will be discussed in Section IV. Figure 1 shows an example of the "Add Field" view in DIMS, which is accessed via the "Add Field" link in the Views menu on the left side of the DIMS website.

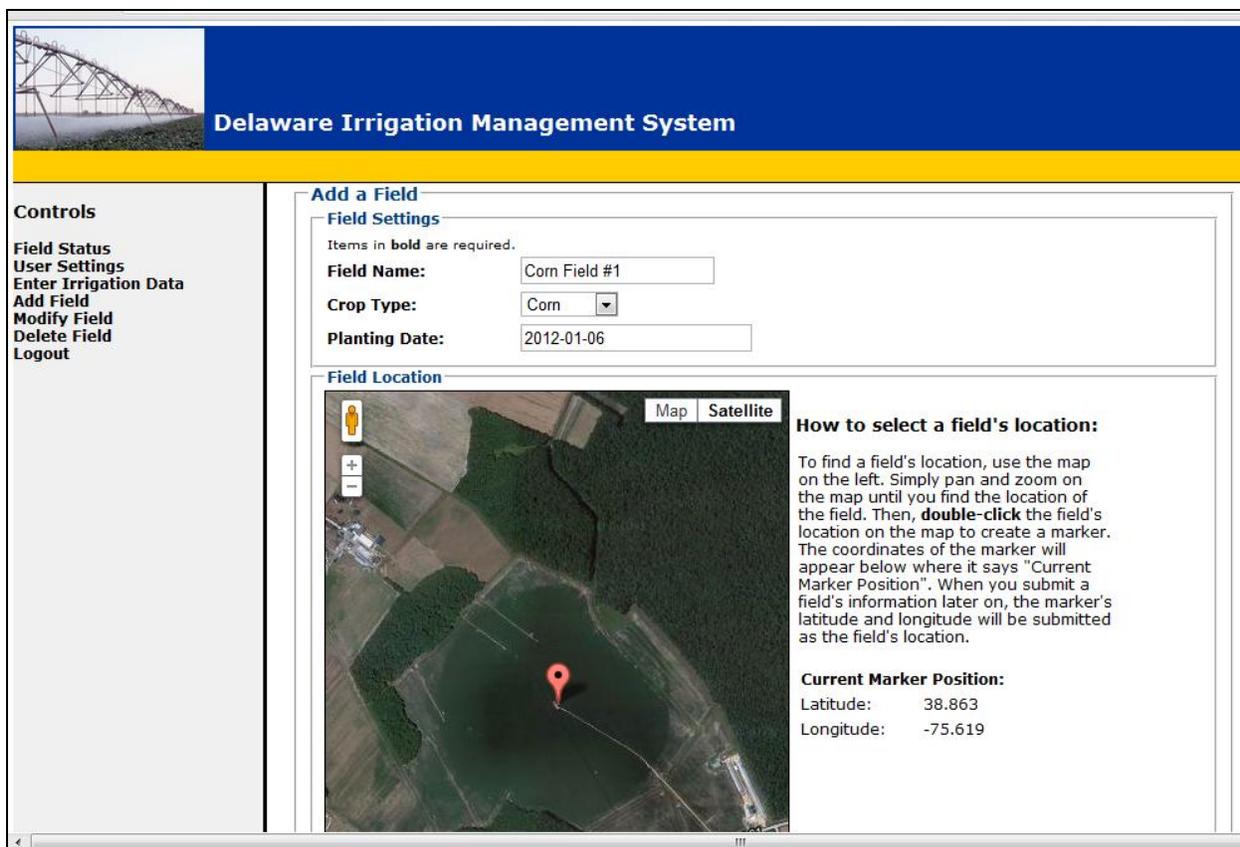


Figure 1. “Add Field” view from DIMS showing the four basic inputs required by the system for each field.

The field name can be any name or set of words the user wishes to use to distinguish one field from another. For crop type, the user may choose between the following crops: corn, soybean, sweet corn, lima beans, peas, watermelons, cantaloupes, and cucumbers. Default properties for each crop type are shown in Appendix A. Depending on the crop chosen, the user will enter a planting date or emergence date for that crop. Currently, only corn and soybean allow for a planting date. All other crops require emergence dates. The planting date or emergence date are chosen from the calendar that appears when the user clicks on the text box next to “Planting Date”/“Emergence Date”. Finally, the location is chosen by using a web mapping interface that automatically determines the field’s geographic location (e.g., latitude and longitude) based on where the user double-clicks on the map. The location conveys a great deal of information to the system, including: initial dominant soil texture class and the locations for the three nearest DEOS weather stations. Appendix B contains default hydrologic properties associated with each dominant soil texture class. Appendix C contains a map of all DEOS stations used in the DIMS system.

IV. Modifying a Field’s Default Settings

While DIMS is intended to be an irrigation scheduling system that requires minimal input from the user, it does allow for changes to be made to some of its default settings. This allows the user the ability to customize key settings to make the soil water calculations more accurate and

specific to each field's location. Currently, the following parameters are configurable under the "Modify Field" link in the Views menu: 1) Field Name, 2) Crop Type, 3) Planting Date, 4) Soil Type, 5) Maximum Allowable Deficit, and 6) Managed Root Zone. Figure 2 shows an example of the "Modify Field" view in DIMS.

Delaware Irrigation Management System

Controls

- Field Status
- User Settings
- Enter Irrigation Data
- Add Field
- Modify Field
- Delete Field
- Logout

Modify Field Settings

Field Settings

Field Name:

Crop Type:

Planting Date:

Season Length (Days): 110

Field Location

Latitude: 38.582

Longitude: -75.353

Advanced Settings

Soil Type:

Maximum Allowable Deficit:

Managed Root Zone:

Figure 2. "Modify Field Settings" view from DIMS showing the various field settings that can be modified after a field has been added to the system. Note that some settings can only be modified prior to the emergence date.

Please note that only field name can be modified after the emergence date (not shown in Figure 2) is determined for a particular field. If a setting (e.g., Soil Type) needs to be changed after an emergence date is found for a field, it is recommended that the user delete the field, add it back to the system, and then modify the necessary field settings. To modify field name, the user simply needs to type a new field name in the text box. Crop type and planting date are configurable by selecting different values from their respective dropdown menus.

The advanced settings are probably of most interest to the user attempting to modify a field. Soil type in particular is an extremely important parameter to configure properly. Since DIMS

automatically selects the dominant soil texture for a given location in Delaware, the user will see the default soil type for that location when they initially attempt to modify a field's settings. The user may change the soil type to any one of the soil types listed in Appendix B, or they may create a custom soil type by selecting "Custom" from the drop down menu. Upon selecting "Custom", two new parameters display called "Average Field Capacity" and "Average Permanent Wilting Point". Users may enter new values here in inches/inches. This will define a custom soil type for the field. Another advanced setting is maximum allowable deficit, which by default is set to 50%. This value represents the soil water availability level where the user feels they will need to begin irrigating a particular field in order to prevent crop water stress. Finally, the third advanced setting that can be modified is managed root zone, which is the maximum depth the user wants to manage soil water for a particular field. The default value for this setting is 18 inches, but can be changed to any depth between 8 and 24 inches.

V. Deleting a Field

Sometimes a user may need to remove a field because its settings were configured improperly or perhaps because they are not managing an irrigation system on the field anymore. For these situations, DIMS provides a "Delete Field" capability. On the navigation menu, the user can select "Delete Field" which brings up a dropdown menu with a list of all fields configured for that user. From there, the user may select the field they would like to delete. A confirmation view displays whereupon clicking "OK" permanently deletes the field from the system. **Users should make sure they want to delete a field before using this capability, as a field and all of its associated data (e.g., irrigation, crop evapotranspiration, soil water availability, etc.) will also be removed at the same time the field is deleted.**

VI. Entering Data

DIMS allows the user to enter three different types of data from the field. The most important data the user can enter is their estimated irrigation applied for each application. Without this information, DIMS will not be able to properly calculate soil water data for irrigated fields. The second type of data a user can enter is field observed rainfall. By default, DIMS uses rainfall data from nearby DEOS stations as its basis for rainfall at each field. However, an observed rainfall value by a rain gauge at the field will be more accurate and thus more representative of the actual rainfall that fell at a particular field. Therefore, it is recommended that users enter their field observed rainfall data for any field where they measure rainfall in order to improve the overall accuracy of soil water calculations performed by DIMS. The third data type is field measured volumetric water content (VWC). This value allows the user to "correct" the scheduler if they feel it is overestimating or underestimating actual soil water availability in the field. Determining this value is typically done through the use of soil moisture sensors, such as a soil water reflectometer. **CAUTION:** Entering VWC data for a field for any particular day will affect soil water availability for all subsequent days in the growing season. Erroneous entries for this data type can cause extreme inaccuracies in DIMS' ability to determine soil water conditions for a field.

The data entry view can be accessed through the “Enter Data” link on the navigation menu. After selecting the field from dropdown list, the user will be presented with the following view shown in Figure 3.

Date	Daily Irrigation Applied (inches)	Daily Rainfall (inches)	Soil Water Availability (%)
02/17/12	<input type="text"/>	<input type="text"/>	<input type="text"/>
02/18/12	<input type="text"/>	<input type="text"/>	<input type="text"/>
02/19/12	<input type="text"/>	<input type="text"/>	<input type="text"/>
02/20/12	<input type="text"/>	<input type="text"/>	<input type="text"/>
02/21/12	<input type="text"/>	<input type="text"/>	<input type="text"/>
02/22/12	<input type="text"/>	<input type="text"/>	<input type="text"/>
02/23/12	<input type="text"/>	<input type="text"/>	<input type="text"/>
02/24/12	<input type="text"/>	<input type="text"/>	<input type="text"/>
02/25/12	<input type="text"/>	<input type="text"/>	<input type="text"/>
02/26/12	<input type="text"/>	<input type="text"/>	<input type="text"/>

Figure 3. Data entry screen in DIMS. Users may enter data for daily irrigation applied, daily rainfall observed at the field, or measured soil water availability.

Users may enter data in one, two, all, or none of the columns for each date. On dates where no data are entered, it is assumed that no irrigation occurred, observed rainfall was not significantly different than the measured rainfall at surrounding DEOS weather stations, and that no soil water availability measurements were taken. After the data are submitted, the field’s soil water calculations are updated for all dates since the earliest date data were submitted. For example, if today’s date is May 15th and the user submits data for May 7th, all soil water calculations will be updated from May 7th through May 14th.

VII. Field Status View

The field status view provides a quick look at each field’s current soil water conditions. For each field created by the user, a summary of its seasonal irrigation, rainfall, and crop evapotranspiration are provided as well as its current soil water conditions, including soil water content as a percentage of field capacity, total soil water content in the crop’s root zone, the root zone deficit in the crop’s root zone, and a qualitative estimate of the field’s soil water conditions in a ‘Status’ column. The status of a field ranges from **very poor** (< 30% of field capacity) to

poor (30% to 50% of field capacity) to fair (50% to 75% of field capacity) to good (>75% of field capacity). For fields that have been created but have not reached emergence, the status for that field will read “Field has not emerged yet.”

Additionally, for all fields that reached emergence, the name of that field in the “Latest Field Water Conditions” table will be hyperlinked to a detailed data page with a graph and data table for the field’s entire growing season (Figure 4). A reporting tool will be made available in the Spring of 2012 to provide users with a print-friendly version of the view or save the detailed view of each page as a PDF.

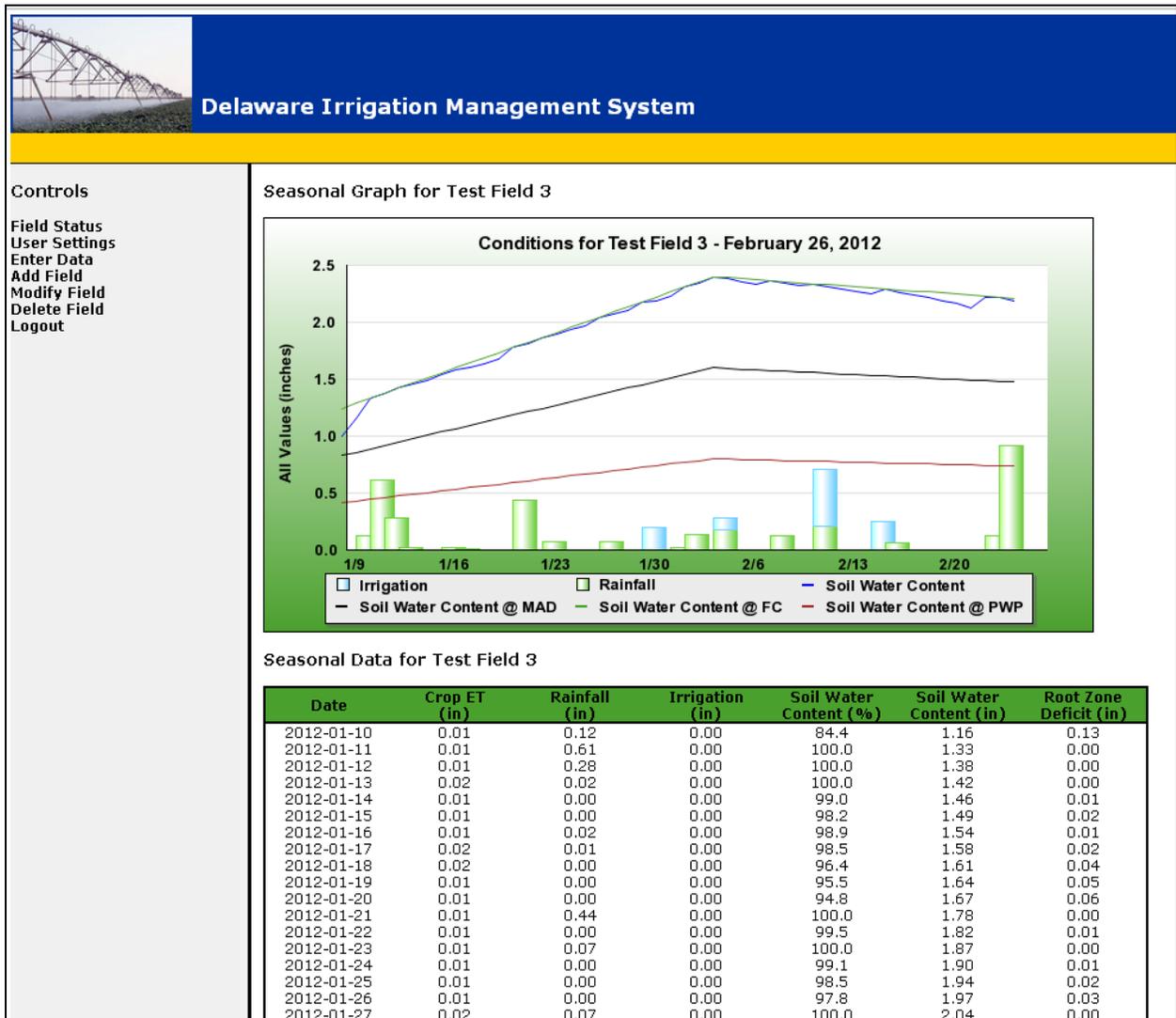


Figure 4. Example of seasonal data view for a field. This view contains a graph showing the seasonal data in graphical form as well as a table listing the seasonal data for the field.

VIII. Funding

Funding for this project was provided by the United States Department of Agriculture's Natural Resources Conservation Service Grant No. 69-21J2-0-12 and the Delaware Department of Natural Resources and Environmental Control Grant No. 08070800964.

IX. Contact Information

To setup an account to use DIMS, to get assistance using DIMS, report an error with DIMS, or just information on the system, please contact:

Kevin Brinson
Delaware Environmental Observing System
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Newark, DE 19709
E-mail: kbrinson@udel.edu
Phone: (302) 831-6906

Appendix A.

Default Crop Growth and Stage Parameters

Please note that items with asterisks (*) beside them are parameters that can be modified in the DIMS system under “Modify a Field”.

Crop Type	Initial K_c	Maximum K_c	Final K_c
Corn	0.25	1.20	0.60
Soybean	0.25	1.15	0.45
Sweet Corn	0.25	1.15	1.05
Lima Beans	0.50	1.15	0.90
Peas	0.50	1.15	1.10
Watermelons	0.40	1.00	0.75
Cantaloupes	0.50	0.85	0.45
Cucumbers	0.50	1.00	0.90

Table 1. Default crop coefficients (K_c) configured in DIMS for each crop type. These parameters adjust how much modeled crop evapotranspiration takes place at each stage of each crop type’s growth cycle.

Crop Type	Season Length (days)	Canopy 10%	Canopy 70%	Canopy Mature
Corn	110	0.17	0.45	0.78
Soybean	110	0.15	0.37	0.81
Sweet Corn	110	0.27	0.56	0.82
Lima Beans	100	0.25	0.50	0.85
Peas	100	0.20	0.50	0.85
Watermelons	110	0.18	0.45	0.73
Cantaloupes	120	0.17	0.58	0.83
Cucumbers	105	0.19	0.48	0.86

Table 2. Default crop stage adjustment factors and season lengths configured in DIMS for each crop type. These parameters adjust the timing of each crop stage for each crop type in the model.

Crop Type	Initial Root Depth (inches)	*Maximum Root Depth (inches)	Emergence Threshold (Growing Degree Days)
Corn	4	24	125
Soybean	4	24	125
Sweet Corn	4	24	N/A
Lima Beans	4	24	N/A
Peas	4	24	N/A
Watermelons	4	24	N/A
Cantaloupes	4	24	N/A
Cucumbers	4	24	N/A

Table 3. Default rooting depths and emergence threshold configured in DIMS for each crop type. The rooting depth parameters affect how much soil water is predicted by the model as the crop type's rooting depth changes. Emergence threshold is used to determine when the crop reaches emergence, a key crop stage in the model, after its planting date. By default, a growing degree day model is used to predict emergence.

Appendix B.

Default Soil Types and Hydrologic Properties

Soil Type	Avg Field Capacity (inches/inches)	Avg Permanent Wilting Point (inches/inches)	Avg Available Water Capacity (inches/inches)
Silty Clay	0.44	0.28	0.16
Clay	0.43	0.29	0.14
Silty Clay Loam	0.36	0.19	0.17
Clay Loam	0.33	0.19	0.14
Sandy Clay	0.32	0.23	0.09
Silt	0.30	0.10	0.20
Silt Loam	0.29	0.11	0.18
Sandy Clay Loam	0.26	0.16	0.10
Loam	0.26	0.12	0.14
Sandy Loam	0.20	0.09	0.11
Loamy Sand	0.15	0.07	0.08
Sand	0.12	0.05	0.07

Table 1. Soil texture classes (soil types) and their associated hydrologic properties. Soil type is configurable in DIMS and custom soil types can be defined as well.

Appendix C.

DEOS Station Locations

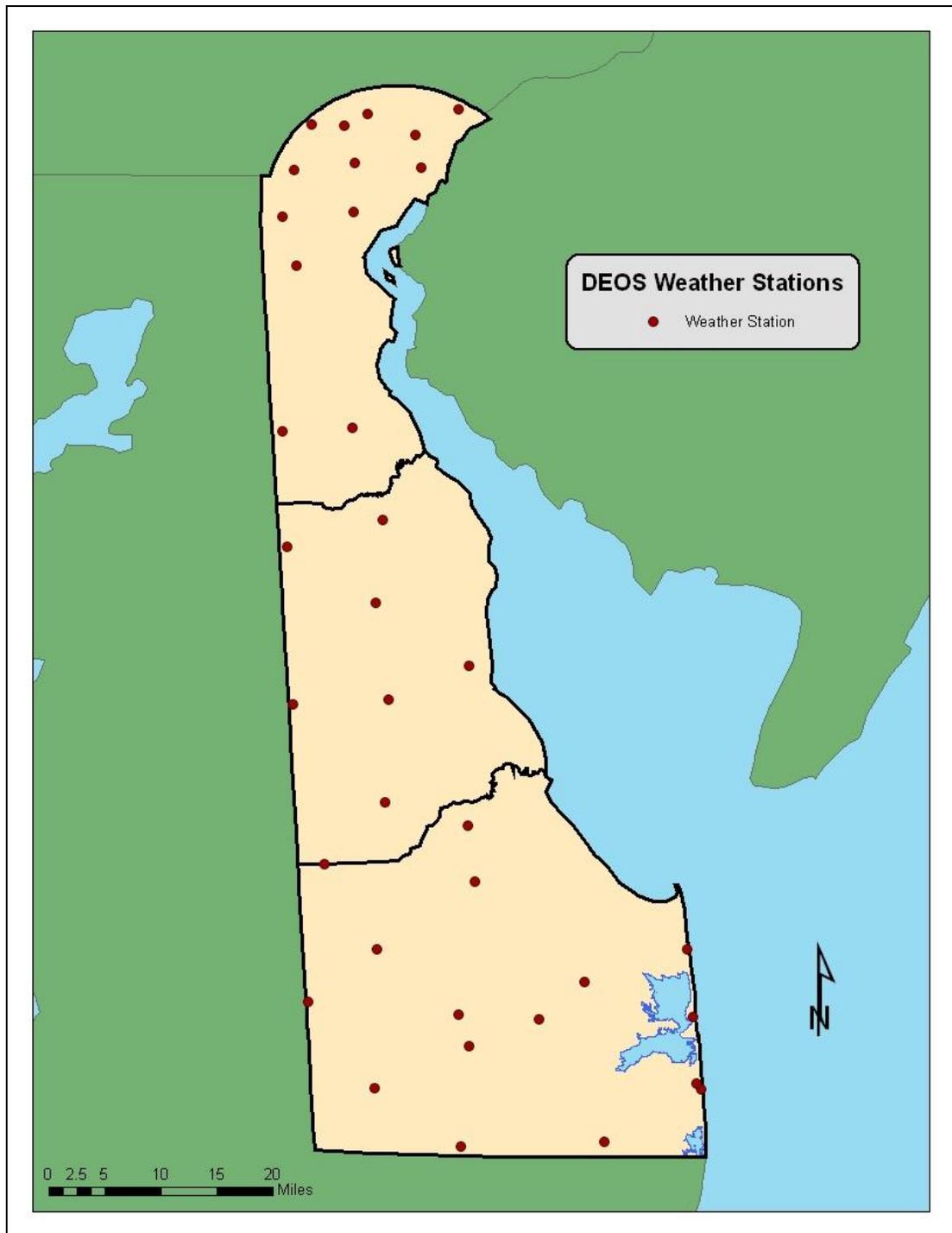


Figure 1. Map of DEOS weather stations (red circles) used in DIMS for reference evapotranspiration and rainfall data.